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# THE VOICES AND RELATIONSHIPS OF THE CHILEAN FROGS *EUPSOPHUS MIGUELI* AND *E. CALCARATUS* (AMPHIBIA: ANURA: LEPTODACTYLIDAE)

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*Abstract.*—The voices of *Eupsophus migueli* and *E. calcaratus* are described. The calls of both species are short in duration and consist of a single note. The call data together with genetic information indicates that *E. migueli, E. calcaratus,* and *E. roseus* comprise a related species group that is quite different from *E. vittatus.*

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Frogs of the genus *Eupsophus* (*E. vittatus, E. roseus, E. migueli, E. calcaratus,* and *E. insularis*) are endemic to the *Nothofagus* temperate forest of southern Chile and Argentina. *Eupsophus migueli* is restricted to the Coastal Range in Valdivia Province (Formas 1978), whereas *E. calcaratus* occurs widely in southern Chile (Formas and M. I. Vera 1982). *Eupsophus migueli* is sympatric but not syntopic with *E. roseus* (Iturra and Veloso, 1981) and this latter species is allopatric with *E. calcaratus* (Formas and M. I. Vera, 1982).

Calls of frogs can be useful in revealing systematic and evolutionary relationships at the species level. In general, closely related species have some acoustic characteristics in common (Blair 1958; Kuramoto 1974, 1977; Mecham 1971; Schiøtz 1973). In order to establish the evolutionary trends of the species of the genus *Eupsophus* we analyzed the voices of *E. migueli* and *E. calcaratus.* These data are compared with the calls of *E. roseus* and *E. vittatus* which were previously described (Formas and M. A. Vera 1980). The voice of *E. insularis* remains unknown. The call data presented in this paper demonstrate that *E. migueli* and *E. calcaratus* show strong similarities with *E. roseus* but that this species group is different from *E. vittatus.*

## Methods and Materials

Field recordings were made at 19 cm/sec on an Uher 4000 Report-IC portable tape-recorder and an Uher m 517 microphone. Audio-Spectrograms were made with a Kay Electric audio spectrograph model 675 employing 85-8000 Hz frequency scale and narrow (45 Hz) and wide (300 Hz) band filters. Temperature, location and behavior of all individuals used in the analysis were taken at the time of recording. Call repetition rates were measured in the field by counting consecutive calls over one minute. Specimens and tapes were deposited in the collection of Amphibians of the Institute of Zoology at the Universidad Austral de Chile (IZUA), Valdivia.

## *Eupsophus migueli* Formas

The call characteristics here described are based on the call of 25 individuals recorded at 9–12°C at the locality of Mehuín (Valdivia Province) during September

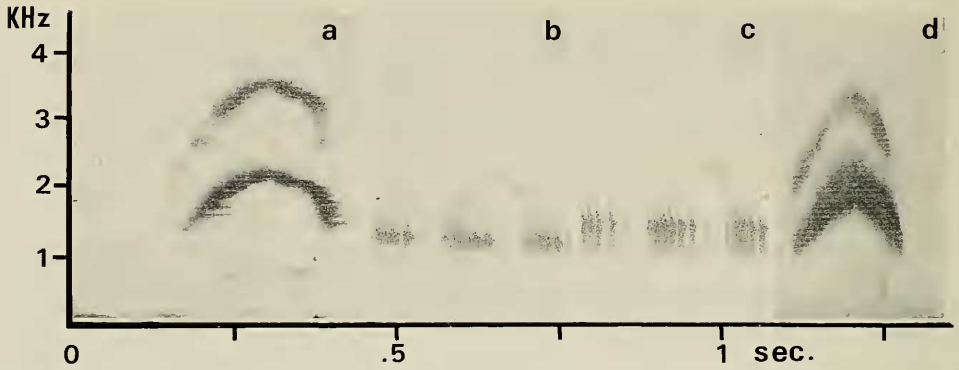


Fig. 1. Sound spectrograms of calls of *Eupsophus migueli* (a, b, c) and *E. calcaratus* (d). a, Type A call (45 Hz); b, Type B call (45 Hz); c, Type B call (300 Hz); d, Call of *E. calcaratus* (300 Hz).

1981. Eight calls, from five specimens were analyzed in detail. Males of this species were observed and collected while they were calling from cavities in the ground near a cool stream. No aggregation of individuals was observed when they were calling but calls of two or more males were organized into duets or trios. Two types of calls were observed. The call type A consists of a single note (Fig. 1a, Table 1) lasting 0.20–0.35 seconds. The repetition rate is 3–8 calls/minute. The call shows poor modulation and a well defined harmonic is present between 3200–3900 Hz. Maximum sound energy is spread over the frequency range 1500–2500 Hz. Type B calls (Fig. 1b, Table 1) of *E. migueli* are trills consisting of 19–33 notes per call. The call duration is 2.7–4.4 seconds and each note last about 0.08–0.09 seconds with poorly defined silent intervals between notes within a call. Each note is composed of 4–7 pulses per note. Maximum sound energy of the poorly modulated notes is spread over the frequency range 900–1500 Hz. The repetition rate is 5–8 calls/minute. Harmonics are absent; the fundamental frequency equals the dominant. This type of call was only observed in two animals.

*Eupsophus calcaratus* (Günther)

The description of the call is based on 15 calls from three individuals. The calls were recorded at 11°C at the locality of Puntra (Chiloé Province) during December 1982. Males were collected while they were calling at the bank of a stream. In this area males are isolated; however, in the locality of Pucatrihue (Osorno Province, October 1983) a moderate aggregation was observed.

The call of this species (Fig. 1c, Table 1) consists of a single note lasting 0.15–0.21 seconds. A well defined harmonic (2200–3800 Hz) is present and the call is poor in modulation. Maximum sound energy is distributed between 1100–2700 Hz. The repetition rate is 16–25 calls/minute.

*Eupsophus roseus* (Duméril and Bibron) and *E. vittatus* (Philippi)

The calls of both species were previously described by Formas and M. A. Vera (1980). The calls characteristic of *E. roseus* and *E. vittatus* are included in the Table 1.

Table 1.—Call characteristic (mean and ranges) of *Eupsophus* species.

| Species | Call type | Notes per call | Call length (sec) | Repetition rate | Dominant frequency (Hz) |
|---|---|---|---|---|---|
| *E. migueli* | A | 1 | 0.24 (0.20–0.35) | 6 (3–8) | (1500–2500) |
| *E. migueli* | B | 24 (19–33) | 3.4 (3.3–4.4) | 6 (5–8) | (900–1500) |
| *E. calcaratus* | | 1 | 0.19 (0.15–0.21) | 19 (16–25) | (1100–2700) |
| *E. roseus*† | | 1 | 0.20 (0.19–0.21) | 64 (60–72) | (1600–2900) |
| *E. vittatus*† | | 5 (4–6) | 0.6 (0.4–0.8) | 4 (2–10) | (1100–2500) |

† From Formas and M. A. Vera (1980).

## Discussion

When two types of calls are produced as in *E. migueli* and some other species (Heyer 1971; Straughan and Heyer 1976; Narins and Capranica 1976; Pyburn 1978), the signals may have a different meaning for the two sexes. Type A call observed in *E. migueli* shows a frequency range between 1500–2500 Hz, a repetition rate of 5–8 calls/minute and the single note lasts 0.20–0.35 seconds. The characteristics here described suggest that the type A call could code information in order to attract gravid females because the frequency is relatively narrow and not difficult to locate, and especially because the call is repeated at predictable intervals. The unusual call type B is a trill with a dominant narrow energy band (900–1500 Hz). This voice was observed at regular intervals (5–8 call/minute) when two males were at the same burrow. Mostly on the basis of this observation we suggest that this signal codes information in order to maintain the territory of a calling male in a particular burrow.

When we compare the voices of *Eupsophus migueli* (call type A), *E. calcaratus,* and *E. roseus* (Fig. 1, Table 1) it is noteworthy that all three species show strong similarities. As suggested above this type of call could be useful in attracting females and, since the calls are similar, they could attract females of any species of this species group. However, this appears unlikely because these species do not occur in the same place. *Eupsophus roseus* and *E. calcaratus* are allopatric in distribution (Formas and M. I. Vera 1982), and *E. migueli* and *E. roseus* are sympatric but not syntopic at the locality of Mehuín (39°26′S, 73°10′W) (Iturra and Veloso 1981).

If we compare the voice of *E. vittatus* with other *Eupsophus* species, two distinctive groups can be established. The first group which includes *E. roseus, E. migueli,* and *E. calcaratus* is characterized by producing a short single note (Table 1). The calls have a distinct harmonic in the frequency range 2200–3900 Hz and a maximum sound energy range between 1500–2500 Hz. All species calls have poor modulation and pulsation. The second group, contains only one species, *E. vittatus.* In this frog the call duration is 0.4–0.8 second and is composed of four to six well pulsed notes. The dominant frequency range is between 1900 and 2500 Hz (Table 1).

Some authors (Blair 1958; Kuramoto 1974, 1977; Mecham 1971; Schiøtz 1973) have suggested that related species have acoustic characteristics in common. If this hypothesis is true, the strong similarities of the calls of *E. roseus, E. migueli,* and *E. calcaratus* suggest that these species are closely related to each other.

Formas (1980) established two species groups in the genus *Eupsophus* based on chromosomal information. The first contains only *E. vittatus,* which has 28 biarmed chromosomes and a fundamental number (FN) of 56. The second group contains the following species: *E. roseus* and *E. calcaratus* (2n = 30, 8 biarmed pairs and 7 monoarmed, and FN 46), and *E. migueli* (2n = 30, 7 biarmed pairs and 8 monoarmed pairs, and FN 44). In addition, Formas *et al.* (1983) analyzed the allozymic differentiation in these species and found that Nei's genetic distance of *E. vittatus* with respect to the other species indicates a higher level of genetic differentiation, whereas the remaining species (*E. roseus, E. migueli,* and *E. calcaratus*) have a lower differentiation when compared with *E. vittatus.* If acoustical and genetic data are compared it is interesting to observe the agreement between both sets of information. This could be useful in establishing systematic and evolutionary trends in the genus *Eupsophus.* On the basis of the evidence previously cited we conclude that the *E. roseus, E. migueli,* and *E. calcaratus* group is comprised of very closely related species while *E. vittatus* remains clearly separated.

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